

Writing in Science

As a scientist, you are a professional writer.

Success as a scientist is not simply a function of the quality of the ideas we hold in our heads, or of the data we hold in our hands, but also of the language we use to describe them. We all understand that “publish or perish” is real and dominates our professional lives. But “publish or perish” is about surviving, not succeeding. You don’t succeed as a scientist by getting papers *published*. You succeed as a scientist by getting them *cited*.

Having your work matter, matters. Success is defined not by the number of pages you have in print but by their influence. You succeed when your peers understand your work and use it to motivate their own. The importance of citation and impact is why journals measure themselves by the Impact Factor and why the citation-based H-factor is becoming more important for evaluating individual researchers. If you have 10 publications that have each been cited 10 times, you have an H of 10; if you have 30 papers that have each been cited 30 times, you have an H of 30; but if you have published 100 papers and none have been cited, on the H-factor you would rate a flat zero. Success, therefore, comes not from writing but from writing effectively.

The power of writing well also explains a pattern I noticed as I was looking for examples to include in this book, a pattern I had only been unconsciously aware of before. When I needed examples of good writing, I could usually go to the leaders in various fields—most write exceptionally well. They are able to cast their ideas in language that is clear and effective and that communicates to a wide audience. Is this pattern accidental? I doubt it. These men and women not only think more deeply and creatively than most of us, they also are able to communicate their thinking in ways that make it easy to assimilate. That is how they became leaders.

Your initial reaction to this observation may be to assume that these people think more clearly than most, and thus they write more clearly. Certainly they do both, but it is less obvious which way causality goes. Does clear thinking lead to clear writing? Or, alternatively, does clear writing lead to clear thinking? The answers to these questions may seem intuitive, but they are not.

I ask, finally, that you avoid one error of belief that is monstrously prevalent. This is the widespread notion that “to write clearly, you must first think clearly.” This sharp little maxim may appear logical, but it is really rubbish. No matter how rational your thought may be (or appear to be) on a particular problem, no matter how detailed your intentions and plottings, the act of writing will almost always prove rebellious, full of unforeseen difficulties, sidetracks, blind alleys, revelations. Good, clear writing—writing that teaches and informs without confusion—emerges from a process of struggle, or if you prefer, litigation.

Most often, the terms of the formula given above need to be reversed: “clear thinking can emerge from clear writing.” Imposing order by organizing and expressing ideas has great power to clarify. In many cases, writing is the process through which scientists come to understand the real form and implications of their work.

SCOTT MONTGOMERY. *The Chicago Guide to Communicating Science*¹

I agree with Montgomery. Often, the process of structuring your thoughts to communicate them allows you to test and refine those thoughts. As you focus on writing clearly, you force yourself to think more clearly. Improving your writing will help you become successful, both because it allows you to communicate your ideas more effectively, making them accessible to the widest audience, and also because it makes your thinking, and thus your science, better.

This brings me back to my original argument—as a scientist, you are a professional writer. Writing is as important a tool in your toolbox as molecular biology, chemical analysis, statistics, or other purely “scientific” tools. Some of these tools allow us to generate data; others to analyze and communicate results. Writing is the most important of the latter. Because it forms the bridge to your audience,

1. S. L. Montgomery, *The Chicago Guide to Communicating Science* (University of Chicago Press, 2003).

it can act as the rate-limiting step that constrains the effectiveness of all the other tools.

Despite the importance of writing, however, for most scientists it is something we do post hoc. After we get the data, we “write up” the paper. This is an unfortunate approach. Because writing is a critical tool, you should study it and develop it as thoroughly as your other tools. Writing is as complex and subtle as molecular biology.

I wish I had a secret I could let you in on, some formula my father passed on to me in a whisper just before he died, some code word that has enabled me to sit at my desk and land flights of creative inspiration like an air-traffic controller. But I don't. All I know is that the process is pretty much the same for almost everyone I know. The good news is that some days it feels like you just have to keep getting out of your own way so that whatever it is that wants to be written can use you to write it.

But the bad news is that if you're at all like me, you'll probably read over what you've written and spend the rest of the day obsessing, and praying that you do not die before you can completely rewrite or destroy what you have written, lest the eagerly waiting world learn how bad your first drafts are.

ANNE LAMOTT, *Bird by Bird*²

Even the most successful writers struggle with writing. It is actually easier for us as scientist writers because as readers, our expectations are low and we want the information—we'll fight through cluttered sentences and disconnected paragraphs to try to get it. But if readers have to fight that fight, some will lose, and then you, the author, will be the greater loser. How many papers are so brilliant, so earth-shattering, so discipline-changing that if you don't read and assimilate them, your research will be blighted and your career will suffer? Do you need more than the fingers on one hand to count them? Most of us never write one. Rather, we build our careers incrementally—our peers read our papers and use our ideas; the more papers we publish and the more they are used, the more successful we are. But our work gets read and cited because we made our points well enough that readers could follow what we were saying. Our proposals are funded because we were able to make our ideas clear, compelling, and convincing to reviewers. Our success, then, comes from our ability to communicate our ideas as much as from their inherent quality. As the author, therefore, your job is to make the reader's job easy.

That last point may be the overriding principle that all the others in this book grow out of, so let me repeat it, louder. *It is the author's job to make the reader's job easy.*

Despite the importance of writing effectively, many respected scientists are at best only competent writers, and we could all be better. Yet most books on science writing take a technical approach to preparing a manuscript, focusing on basic

2. A. Lamott, *Bird by Bird* (Anchor Books, 1994).

information such as how to structure a paper, whether to use figures or tables, and how to manage the process of submitting a paper and dealing with editors and reviewers. Those books are more about publishing than about writing; they treat writing as something a scientist *does*.

I take a different approach—treating *being a writer* as something a scientist *is*. That distinction may appear subtle, but it is profound. If writing is merely something you do, like washing the glassware after an experiment—a perhaps unpleasant afterthought—you will never be a successful writer. You will not invest in sharpening your tools or expanding your toolbox; you may not be aware that you even have a “writing toolbox.” That changes when you recognize that you are a writer and accept it as your profession. Professionals pay attention to their craft, study it, analyze the work of peers to learn from them, develop new tools, and experiment with new approaches. They grow in their ability to perform with style and power, whether that be to create wooden chairs, legal arguments, life-saving surgeries, or scientific papers that become classics. If you want your writing to be effective, become a writer.

This book is unapologetically on the craft of writing—communicating through the written word. I won’t tell you how to put together a figure, how to assemble a bibliography, or how to decide where to submit the paper. There are excellent books that cover that material, and I intend this book to complement rather than replace them. Instead, I target scientists—from students to working professionals—who are ready to go beyond the basics and become writers.

While focusing on the specific issues we face as scientists in producing papers and proposals, I approach the challenge of technical writing from the perspective of a writer, thinking about the issues the way professional writers do. Thus, a large part of the book is about story and story structure—how you lay out issues, arguments, and conclusions in a coherent way. If you can’t deal with the big issues, the small ones don’t matter very much. Good tactics never overcome bad strategy. Then I move on to finer scales, from overall story structure through paragraphs and sentences to how we choose individual words. The final section covers specific challenges that arise in different types of science writing.

1.1. WRITING VERSUS REWRITING

One thing to keep in mind as you read this book and apply the ideas to your own work is that this is really a book about rewriting, not writing. Every single thing I tell you not to do, I do in my first drafts—I may do them less than I used to, but I still do them. First drafts, though, don’t matter; no one else sees them. Trying to get a first draft perfect can be paralyzing, a phenomenon well recognized by the best writers on writing.

A warning: if you think about these principles *as you draft*, you may never draft anything. Most experienced writers get something down on paper or up on the screen as fast as they can, just to have something to revise. Then as

they rewrite an earlier draft into something clearer, they more clearly understand their ideas. And when they understand their ideas better; they express them more clearly, and when they express them more clearly, they understand them even better . . . and so it goes, until they run out of energy, interest, or time.

JOSEPH WILLIAMS, *Style: Ten lessons in clarity and grace*³

Rewriting is the essence of writing. I pointed out the professional writers rewrite their sentences over and over and then rewrite what they have rewritten.

WILLIAM ZINSSER, *On Writing Well*⁴

The last word on rewriting comes from Anne Lamott, who addresses it with humor and insight:

Shitty First Drafts. All good writers write them. That is how they end up with good second drafts and terrific third drafts.

I know some very great writers, writers you love who write beautifully and have made a great deal of money, and not one of them sits down routinely feeling wildly enthusiastic and confident. Not *one* of them writes elegant first drafts. All right, one of them does, but we do not like her very much.

Unfortunately, this quote highlights just how wonderful a writer Lamott is—her third drafts are terrific. When I finish a paper, there are usually 10 or 20 drafts cluttering up my computer, and I only think the last one is terrific until I reread it later. Rereading things I've written is often painful; imperfections glow like neon signs, leaving me to wonder how I ever managed to miss them in the first place.

Writing can be a painful process of rewriting, rewriting, and more rewriting until your work gets good enough to send off. An artist never completes a work—they merely let it go. This rewriting cycle develops both your writing and your thinking, moving both toward clarity and power. How do you get to Carnegie Hall? Practice, practice, practice! How do you get an award letter from the National Science Foundation or the National Institutes of Health? Polish, polish, polish! If you are going to be a successful writer, learn to embrace the pain and enjoy the process.

3. J. M. Williams, *Ten Lessons in Clarity and Grace* (Longman, 2005).

4. W. Zinsser, *On Writing Well* (HarperCollins, 1976).